

INTELLECTUAL PROPERTY
OEPARTMENT

## Invention Disclosure

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N	ame:Chok Ho
D	ate:07/31/00
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	ternal e-mail (MSMail or TeamLinks): <u>Chok Ho@lamrc.com</u> <u>Artin Tang@lamrc.com</u> <u>Charlie Lee@lamrc.com</u>
la.	Project Name; Use of Ammonia (NH3) for Etching Silk. an organic Low-k
1Ъ.	Technology:Dielectric Etch
1c.	Business: (Circle One) • Conductor Etch • Dielectric Etch • CMP • Clean • New Product Development • Platform Engineering • Software Other
1d.	Lam Product(s): Exelan-HP
2.	Title or subject matter of your invention:
	Use of Ammonia (NH3) for Etching Silk, an organic Low-k Dielectric.

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NO. 522 P. 13...

3. Please attach a brief, yet thorough, description of what your invention is and how your invention operates or performs. Describe the preferred and alternative ways in which your invention would be implemented. Attach and identify copies of all known drawings, sketches, (flow-charts for software), formulae, descriptions, data, articles, etc., of your invention, including copies of your lab notebook entries (dated and witnessed).

NH3 is used to etch Sil.K, an organic low-k dielectric. NH3 is used because it has a much lower ionization potential than traditional etchants of Sil.K, such as N2/H2. Because of the lower ionization potential, higher plasma density and higher Sil.K etch rate can be achieved using NH3 rather than N2/H2 for the same process conditions. In addition, the NH3 plasma is much more stable than a N2/H2 plasma, given the same processing condition. We believe that where there is insufficient ion hombardment, such as on the sidewalls of the Vias/Trenches, NH3 reacts with the Sil.K and forms a polymer consisting of (=CH-N=)n groups arranged in a 3-dimensional matrix. The HCN polymer passivates the sidewall and prevents profile bowing.

- 4a. Describe any <u>prior art</u> (e.g., known existing products, methods, publications or patents) of which you are aware and which relate to your invention;
- 4b. State in detail the <u>advantages</u> that your invention has over this prior art and how your invention <u>distinguishes</u> over this prior art:

The use of NH3 has many advantages over prior chemistries for etching Sil.K. NH3 has a much lower ionization potential than N2, a component of prior chemistries used for etching Sil.K; this leads to the following advantages over other traditional methods for etching Sil.K:

- Higher SiLK etch rates, about 2.5 times higher etch rate than using N2/H2 chemistry.
- Profile angle is independent of feature size. All feature sizes show very similar profile angles.
- Forms an HCN-type polymer on the sidewall of the SiLK Via/Trench structures which passivates the sidewalls to prevent profile bowing due to lateral etching/ion bombardment and also prevents poisoning of the structures due to outgassing of solvent from the SiLK during subsequent barrier metal deposition.
- Higher selectivity of SiLK to Oxide or Nitride hardmask materials.
- Allows for a more stable plasma over a wider pressure and power operations regime than N2 containing chemistries.

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5.	Conception/Reduction/Commercial Use:
	Date of first conception:
	Date of first notebook entry
	Where conceived?:Fremont. CA
	Was invention reduced to practice (made/used)? (yes/no): Yes  If yes, date first reduced:
	Is commercial or public use planned (yes/no):  If yes, date of expected or actual public disclosure or offer for sale:
	Was invention result of co-development project with others? (yes/no): No H yes, explain (include whether NDA in place):
6.	Did invention occur during performance of a government contract? (yes/no): No
7.	Give names of other persons familiar with or who have worked on the project, but who do not claim an inventorship interest in the invention (please identify the project or intended product):
	Reza Sadjadi, Jim Tietz, John Lang. Rao Amanyagada

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8.	For each inventor, please provide the following information (copy & paste as necessary):
8a	Legal Name (as you intend to sign application):Chok W. Ho Employee #:4935
	Dept #: 20011
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	Names of Supervisor, Director, and Vice President: Reza Sadiadi. Jim Tietz.  Nick Bright
3D.	Legal Name (as you intend to sign application): Artin Tang
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	Citizenship: Taiwan
	Names of Supervisor, Director, and Vice President: <u>Alfred Tsai, Young-Tong Tsai</u>
9.	Inventor's Signature(s) and date signed:
	Chale 6. Ho #/1/2000
10.	Witnessed & Understood By (include date):

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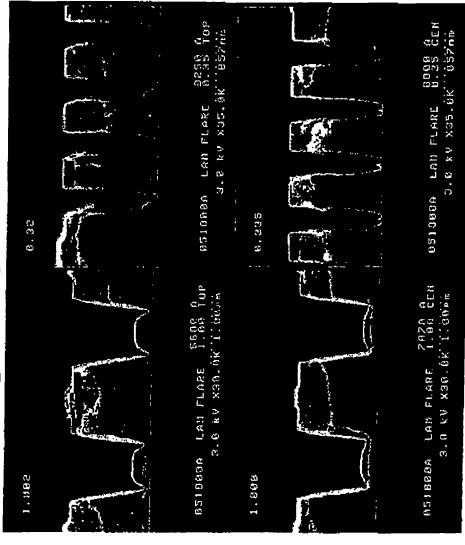
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Wafer # 051800A (ESC @ - 10°C) 70 MT/ 500/1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 30"

55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"

160 mT/ 700/ 0/ 1000 NH3/ 90"

ER = 5269 A/min; ER Uniformity < 3.4%; RIE Lag = - 40.1%



Chok Ho (SiLK Etch Development)

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3.0 xv x35.0x 357nm

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Wafer # 051800C ( ESC @ - 10°C ) 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 30"

55 mT/ 1400/ 11⁄/ 140 Ar/ 9 O2/ 15 C4F8/ 10"

160 mT/ 700/ 0/ 600 NH3/ 90"

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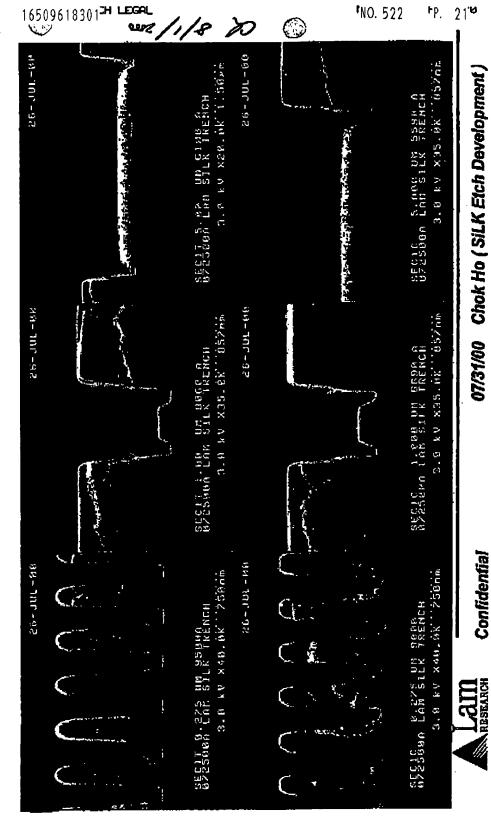
3.6 kV X35.8K '057nm LAM FLARE ER = 5032 A/min; ER Uniformity < 12.3%; RIE Lag = - 42.4% 2808158 ខាន ១៨ភ S10.8 5688 n 1.86 Top उ. व. ४५ - ४३६. नेहें ों . जेब्रेज़ि LAM FLARE 851088C 906.8 B. 923

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Chok Ho ( SILK Etch Development, 07/31/00

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70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28" Nafer # 072500A ( ESC @ 0°C ) (Partial Etch) 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10" 60 mT/ 500/ 0/ 300 NH3/ 150" ER = 3326 A/min; ER Uniformity  $\leq$  9.3%; RIE Lag = - 34.5%



Chok Ho ( SILK Etch Development )

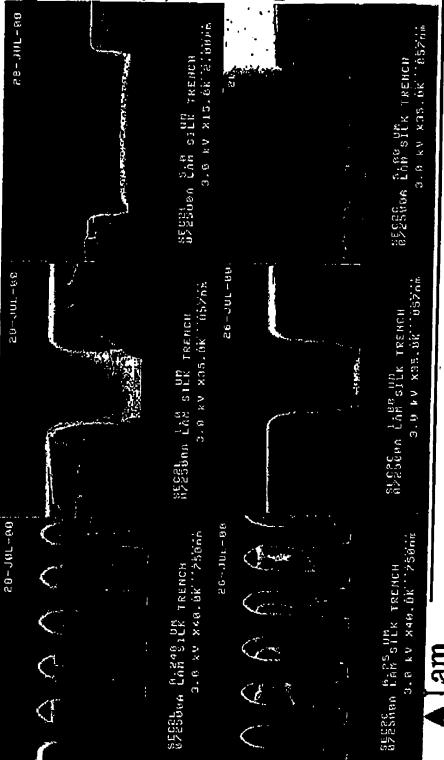
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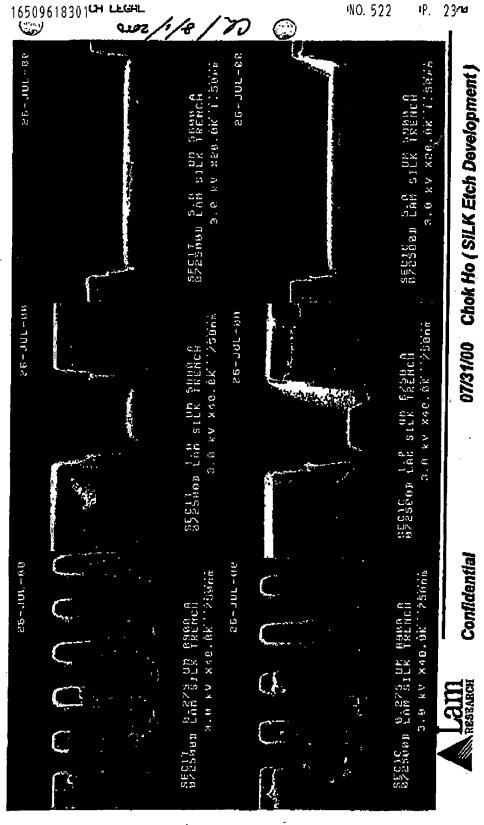
Wafer # 072500A (ESC @ 0°C) (57.5% Overetch) 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"

55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10" 60 mT/ 500/ 0/ 300 NH3/ 270"

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Wafer # 072500B ( ESC @ 0°C ) (Partial Etch) 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28" 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10" 160 mT/ 500/ 0/ 600 NH3/ 115" ER = 3959 A/min; ER Uniformity < 7.6%; RIE Lag = - 53.4%



70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"

Wafer # 072500B ( ESC @ 0°C ) (45.9% Overetch

160 mT/ 500/ 0/ 600 NH3/ 210" (PR Cleared @ 95")

55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"

38-10r-38

3.8 kV x48.6K" 250nm

3.8 XV X48. AK 75666

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88-10C-88

3.8 FV X15.68 2:8854

3.0 kV 848.0K 759mb

OZESGED LAB SILK TRENCH

07/31/00 Chok Ho (SILK Etch Development)

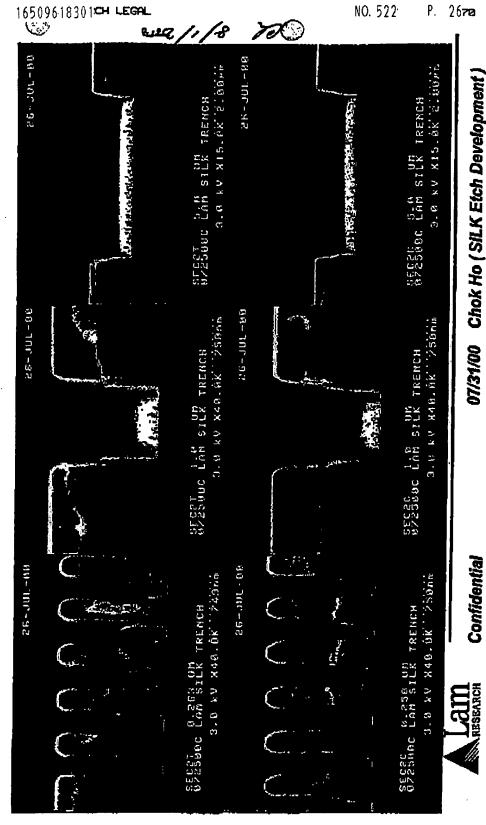
Wafer # 072500C ( ESC @ 0°C ) (Partial Etch)
70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
160 mT/ 500/ 0/ 1000 NH3/ 95"

36-JUL-86 88-106-98 3.8 kv x28.8KTISELE 3.6 kV X28.8K 1.58Fh SPECIT S.R UN 4958 A N7258BC LAN SILK TREACH SPCIC S.B UN SSSB A 26-JUL-MB 58-10L-68 3.8 x v x 4 8. 8 X 7 5 5 6 6 6 3. H tv x16. 6K 758nr SCOIR LAB SILK TRENCH SECTO TO UN SONO NESSON ER = 3853 A/min; ER Uniformity < 4.0%; RIE Lag = -18.3%38-10L-88 26-JUL-09 SECICE GRESTE UN SARRACEBUAR BZESSUC LAB SILK FRENCH 3.0 kv x40. bk 756AAm 3.8 kV x48.8k" 75868 SECT W.297 UN GASE A SEC1C should be 6600A

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(PR Cleared @ 84") Wafer # 072500B (ESC @ 0°C) (16.3% Overetch) 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28" 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10" 160 mT/ 500/ 0/ 1000 NH3/ 172"



6.2005≈ 3:11PMPPM • **4**170°

70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28" Wafer # 072500D ( ESC @ 0°C ) (Partlal Etch) 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10" 100 mT/ 500/ 0/ 600 NH3/ 115"

aa-100~22 ยถ-ากก-22 3.8 kV X18.8K T.67Fm 3.8 KV X18.6X 1.67 F. BECLT S.R UN SOOR O SECIC 5.9 UK SABY A BZZJUBD LAM SILK IRENCH 27-JUL-68 27-JU1-78 3.6 EV X40.9K" 255hh SECIT I'B UN BORB A BRZSBBI LAN SILK TRENCH ER = 3509 A/min; ER Uniformity < 5.7%; RIE Lag = - 25.6% 3.8 KV X46.6K SFCIC LAN SILK 39-10r-22 52~10L-88 3. 8 kV X48. 0K 75866 SECIC BARDIER TRENCH SECTION 0.323 UN 7886 A SEC1C should be 6600A

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Chok Ho (SiLK Etch Development) 07/31/00 (PR Cleared @ 78")

Wafer # 072500D ( ESC @ 0°C ) (29.3% Overetch) 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"

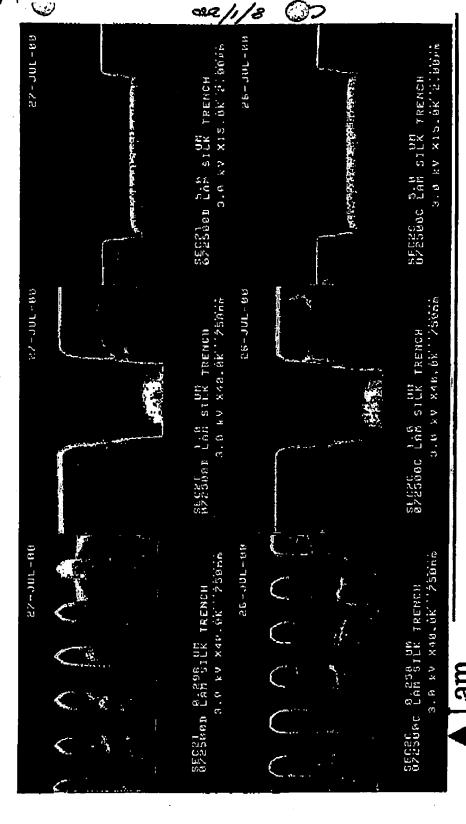
55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"

100 mT/ 500/ 0/ 600 NH3/ 210"

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07/31/00

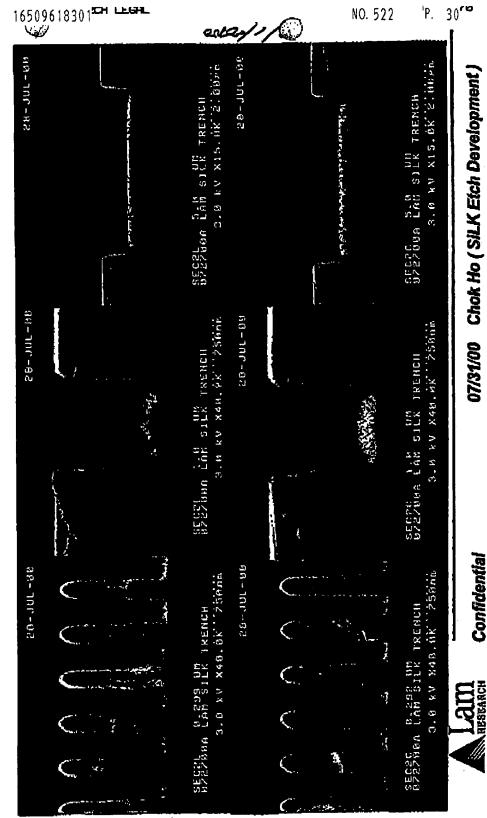
Wafer # 072700A (ESC @ 20°C) (Partial Etch) 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28" 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10" 160 mT/ 500/ 0/ 600 NH3/ 100"

ลด-ากก-คอ 23-10r-22 SECIT 5.0 UN SECHZEIBBA UZZZOBO LAM SILK IREMON a. 8 xv xis. 8x 8. 8 8 8 a 3.0 kV X18.9K 7.6774 SECIC 5.8 UP SSMB O BZZSGBB O BZZSGBB LAM SILK TRENCH an-10r-az 84-106-82 O. B KV MAB. OK VSSKIM 3. B RV X48. 88 7 258 A. SECIC L.B. UT GOBG A SEDIT 1.8 UR SSSW A BZZZBUA LAB SILK TRENCH ER = 3752 A/min; ER Uniformity < 2.9%; RIE Lag = - 6.9% 88-JUL-88 20-186-89 SECJU B.385 UR FARBO BZZJUR LAK SILK TRENCH 3.0 KV XAB.ÖK ZÖBBR 3.8 kV X48.8X 758nb SECIT RIBBE UN GREBGH 072788A LAM SILK TRENCH

222

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160 mT/ 500/ 0/ 600 NH3/ 150" (PR Cleared @ 82") Wafer # 072700A (ESC @ 20°C) (1% Underetch) 70 WT/ 500/ 1K/ 180 Ar/ 15 C2/ 5 C4F8/ 40 CF4/ 28" 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"



Increases ER, decreases ER Non-uniformity, decreases RIE Lag

Decreasing Pressure:

Decreases ER, decreases ER Non-Uniformity, decreases RIE Lag

Increasing ESC Temperature\*:

- Decreases ER, decreases ER Non-uniformity, decreases RIE Lag



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07/31/00

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